Difficult Technical Challenges of Open Infrarenal Abdominal Aortic Aneurysm Repair and How to Meet Them

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K. Wayne Johnston, MD, FRCS, Toronto, Ontario, Canada

In the open treatment of abdominal aortic aneurysms (AAA), the surgeon may encounter several situations that alter the standard operative procedure. The following describe some of the technical problems that can be encountered and the alternative management strategies. The specific statistics cited are obtained from the Canadian Aneurysm Study (see References).

Difficulty Maintaining Pelvic Flow

Internal iliac artery blood flow should be maintained if possible. In the Canadian Aneurysm Study, when internal iliac flow was maintained to one or both sides, the incidence of clinically apparent ischemic colitis was 0.3%, but when flow was interrupted bilaterally, ischemic colitis occurred in 2.6%. This observation and the current data from endovascular repairs support the principle that internal iliac artery flow should be maintained to at least one side. If both internal iliac arteries are aneurysmal, it may be very difficult to maintain pelvic flow; however, in other cases, it may be feasible to supply the pelvis using a separate graft from the aortic graft to the internal iliac. If the internal iliac is mildly aneurysmal, it may be feasible to bypass into the vessel and accept the need for careful follow-up and the potential need for endovascular obliteration at a later time.

Inferior Mesenteric Artery Reimplantation

Although the inferior mesenteric artery (IMA) was reimplanted in 4.8% of the cases, the criteria for this procedure are not clearly defined. Certainly, IMA reimplantation is justified if there is poor back flow from a patent inferior mesenteric artery after the distal anastomosis is completed, if there is concern that the reconstructive procedure has reduced pelvic flow, if preoperative investigation indicate that there is mesenteric or pelvic occlusive disease, or if the colon appears ischemic. Inferior mesenteric artery reimplantation has been recommended based on the results of certain measurements including stump pressure and measurements using Doppler ultrasound, photoplethysmography, or colic pH. For example, if the inferior mesenteric artery is patent and the stump pressure < 40 mm Hg, reimplantation is suggested. In his practice, the author has not found these investigations to be useful.

Inflammatory Aneurysm

Although management of inflammatory AAA may be simplified by endovascular repair, in some cases, the difficult technical challenge of an open repair may be necessary. Dense fibrosis enveloping the aorta and adjacent structures including the duodenum and ureters was observed in 4.5%. In some cases, the diagnosis may be suspected clinically because the incidence of pain is higher in those patients with an inflammatory aneurysm by comparison to a standard aneurysm (30.0% vs 17.2%). Preoperative diagnosis is often possible by computed tomographic (CT) scan, which typically shows a thickened homogeneous aortic wall, particularly anteriorly and laterally. Because of the vascularity of the periaortic tissue, it enhances with contrast injection. Ureteric abnormalities may be diagnostic. The ureters may be obstructed and/or drawn medially by the fibrosis rather than displaced laterally by the aneurysm.

The following principles of operative management should be followed: do not dissect the duodenum off the aneurysm but rather open the aneurysm toward the left side away from the duodenum; clamp the aorta at the diaphragm if necessary; obtain distal control of the iliac arteries with balloon catheters; use an autotransfusion system; and perform the upper anastomosis by the inclusion method, if required. Although the treatment of associated ureteric obstruction is controversial, because the inflammatory reaction usually resolves spontaneously after aneurysm repair, ureterolysis can be avoided in most cases.

Horseshoe Kidney

Although a horseshoe kidney occurs in only 1 in 400 patients, it is a major challenge for the vascular surgeon. On a CT scan, a horseshoe kidney is seen anterior to the aortic aneurysm. The anomaly involves the isthmus, ureters, arterial supply, and venous drainage. The isthmus is bulky because the kidneys are fused at the lower poles in most cases. Ureters may arise higher than usual from the collecting system, lie more laterally than normal, and be double. Because of these abnormalities, urine drainage may be slow and the diagnosis of a horseshoe kidney should be considered if the patient has a history of recurrent kidney stones or genitourinary infections. The arterial supply is variable. Single renal arteries are present in only 20%. In the 80% of cases with multiple renal arteries, there is little collateral circulation between the individual renal segments. For this reason, detailed arterial imaging is mandatory in all cases. The venous drainage may be into the inferior vena cava, common iliac, external iliac, and sacral and/or inferior mesenteric veins.

With a complete knowledge of the arterial blood supply, an aortic aneurysm associated with a horseshoe kidney can be repaired using the standard anterior approach or preferably a retroperitoneal approach. An anterior approach can be used if there are single renal arteries and the aneurysm repair is straightforward. In most cases, the isthmus can be elevated off the aneurysm to allow access to the anterior wall of the aorta and facilitate a standard repair. There is rarely justification to divide the isthmus of the horseshoe kidney and risk a urine leak. A retroperitoneal approach is preferred in most cases and is definitely indicated if there are multiple renal arteries or the aneurysm is complex. From this exposure, the aneurysm is opened and accessory arteries identified. The accessory renal arteries are sewn onto the graft.

Aortocaval Fistula

Aortocaval fistulae were present with an incidence of 0.5% of AAAs. The reported mortality is approximately 50% but can be improved by early diagnosis and knowledge of the principles of treatment.

Early accurate diagnosis depends upon knowledge of the pathophysiology of the condition and the clinical presentation. Patients may present with symptoms and signs related to the systemic effects of a large acute arteriovenous fistula, a local reduction of peripheral arterial flow, and/or local venous hypertension. With an acute large AV fistula, simultaneously peripheral arterial resistance falls and venous return increases. As a consequence, heart rate, stroke volume, and cardiac output increase. Mean blood pressure falls and because of reduced renal perfusion and stimulation the renin-angiotensin system, sodium and water are retained, and the blood volume increases. These changes are manifested by a widened pulse pressure, edema, and congestive heart failure. There is preferential flow into the low resistance fistula and not to the distal arteries. As a result of a local reduction of peripheral arterial flow, the legs are cool and peripheral pulses reduced. Local venous hypertension may affect multiple sites. As the result of increased venous pressure on the legs, edema and cyanosis are noted and during the acute stage this may mimic deep vein thrombosis. Owing to the effects on the liver, hepatomegaly is noted; on the kidneys, oliguria and hematuria; on the bowel, pain and gastrointestinal bleeding.

At the onset, the patient often experiences acute pain owing to distention of the IVC or the effects of venous hypertension on the liver or bowel. A continuous bruit is diagnostic. The diagnosis is certain if there are other manifestations of an aortocaval fistula including edema, congestive heart failure, cool extremities and reduced peripheral pulses, and oliguria.

Ideally, the diagnosis should be established preoperatively, and this will allow planning of a careful operation. If open repair is necessary, full hemodynamic monitoring is important because the patient has a high cardiac output and usually an increased blood volume. With cross-clamping, it is anticipated that the systemic vascular resistance will precipitously increase and venous return will fall—profound changes by comparison to the usual case.

Proximal control is obtained in the usual way but the aortic clamp should be applied slowly to minimize the systemic hemodynamic changes. While removing the mural thrombus from within the aneurysm, the surgeon should be careful not to cause an air or atheromatous embolus. A cell saver is used. Bleeding is controlled by direct pressure on the cava from within the aneurysm or by using large IVC occluding catheters that can be positioned through the hole in the aorta or, if the diagnosis is made preoperatively, by inserting them up from the saphenous vein in the groin. Often the bleeding can only be partially controlled and it is most expeditious simply to accept the blood loss and go ahead and close the fistula. The hole is closed using a running monofilament suture or pledgeted sutures. The aorta must be manipulated with care to prevent air or atheromatous emboli during dissection of the aneurysm or application of the aortic cross clamp. Bleeding from the fistula can usually be controlled by direct pressure while the hole is closed.

Coexisting Renal Artery Stenosis

Renal artery bypass can be performed with a relatively low morbidity and mortality in selected patients. However, what are the indications for renal artery bypass along with aneurysm repair? If there is no hypertension and no azotemia, no operation is indicated. Although it is tempting to argue that all significant renal artery stenoses should be repaired at the same operation to prevent future renal damage, there are no data to support prophylactic surgery to prevent hypertension or azotemia. If the patient has hypertension and a unilateral renal artery stenosis but the lesion is not functionally significant as assessed by renal vein renin measurements, no operation is indicated. If the hypertension is poorly controlled and/or the patient is on multiple drugs that may invalidate the renin results, a bypass may be justified even if the renins are normal. If the patient has hypertension and a unilateral renal artery stenosis that is functionally significant, a simultaneous bypass is indicated. If the patient has hypertension and bilateral lesions, irrespective of the results of the renin studies, renal artery repair is indicated. If the patient has azotemia but only a unilateral stenosis, the renal failure is most likely on the basis of parenchymal disease and no operation is indicated. If the patient has azotemia and bilateral severe stenoses, renal bypass grafts are justified.

Accessory Renal Arteries

Significant accessory renal arteries were present in 2.6%. Some authors recommend reimplanting all accessory arteries because of the risk of hypertension resulting from a segment of ischemic kidney; however, this risk is low and I only reimplant large branches. Accessory renal arteries can be reimplanted using the traditional approach of removing a button of aorta with the renal artery orifice and sewing it onto the side of the graft. Alternatively, it is often easier to reimplant the renal artery directly into the side of the graft.

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Venous Anomalies

Venous anomalies are significant because of the risk of injury and serious bleeding.

If a left-sided IVC prevents access to the neck of the aneurysm, it may be necessary to divide the cava. Alternatively, the right renal vein can be divided to allow mobilization of the cava to the left and provide adequate exposure. If a circumaortic renal collar is present, the neck of the aneurysm must be mobilized with care to prevent injury to this anomalous posterior vessel.

The risk of bleeding from an undetected retroaortic renal vein can be minimized by suspecting the anomaly if a normal anterior left renal vein is absent or the vein is small, by avoiding circumferential dissection around the neck, and by gently applying the aortic clamp in the anterior-posterior direction. Management of a lacerated retroaortic renal vein is difficult. The injury is tamponaded and the aortic clamp moved more proximal to allow division of the back wall of the aorta and direct suture or ligation of the lacerated vein.

References

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